

Title: A review of Ruffe (*Gymnocephalus cernuus*) life history in its native versus non-native range

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Abstract: Invasive Ruffe (*Gymnocephalus cernuus*) have caused or have the potential to cause negative economic and ecological impacts in North America (particularly the Laurentian Great Lakes), the European Union, Scandinavian countries, and the United Kingdom. To better predict potential future habitat and ecological impacts, we need to characterize their present habitats and life history requirements. Thus, the objective of our study was to define the native and non-native range and to examine the life history requirements of Ruffe. Their native range extends from the coast of the Arctic seas in eastern Scandinavia in the north to the Danube River and Black and Caspian Seas in the south. Ukraine and western Siberia make up the eastern border and the Netherlands form the westernmost border. Ruffe have established populations in Italy, England, Scotland, Wales, Germany, Norway, and the U.S. The life history requirements of Ruffe vary among life stages and between the native and non-native range. For example, Ruffe live in shallow, warm water and remain stationary as larvae; whereas, they live in deep, cool water and make daily and seasonal movements in later life stages. Between their native and non-native range, Ruffe diets are extremely variable—in the native range, they primarily eat chironomid larvae and pupae, and in their non-native range, food items include zooplankton, caddisflies, mayflies, Mysis, and fish eggs. Adult Ruffe age and size at maturity, maximum age and length, reproductive behavior, genotype, feeding habits, and movements allow them to readily adapt to novel environments. We conclude that all of the Great Lakes and many other regions in the U.K., Europe, and Scandinavian countries are vulnerable to a Ruffe invasion, making early detection and rapid response important throughout these systems.